

## Low Cost Variable Conductance Heat Pipe for Balloon Payload, Phase I

Completed Technology Project (2011 - 2011)



## Project Introduction

While continuously increasing in complexity, the payloads of terrestrial high altitude balloons need a thermal management system to reject their waste heat and to maintain a stable temperature as the air (sink) temperature swings from as cold as -90

o

C to as hot as +40

o

C. Currently, constant conductance, copper-methanol heat pipes are utilized on balloon payloads to remove the waste heat. It would be desirable to use a Variable Conductance Heat Pipe (VCHP) instead, to allow the thermal resistance to increase under cold operating or cold survival environment conditions, keeping the instrument section warm. In spacecraft, thermal management is achieved using axially-grooved aluminum-ammonia heat pipes and VCHPs, which are relatively expensive to manufacture and validate. Advanced Cooling Technologies, Inc. (ACT) is proposing a low-cost VCHP based on smooth-bore, thin-wall stainless steel tubing, with either methanol or pentane as working fluids, that is capable of passively maintaining a relatively constant evaporator (payload) temperature while the sink temperature varies between -90

o

C and +40

o

C. The thin wall will be much lighter and will provide much better temperature control due to its higher thermal resistance, while the combination of working fluid and envelope material result in a heat pipe that is much less expensive to manufacture than standard grooved aluminum heat pipes. Spacecraft VCHPs normally have the gas reservoir at the end of the condenser, and maintain its temperature with electrical heaters. The proposed VCHP moves the reservoir near the evaporator, eliminating the need for electrical power to control the temperature. Preliminary calculations show that either system, methanol based or pentane based, is capable of meeting the thermal performance requirements. For both the pentane and methanol systems, the evaporator (payload) temperature varies less than 6

o

C while the heat sink temperature varies from 90

o

C to +40

o

C.



Low Cost Variable Conductance Heat Pipe for Balloon Payload, Phase I

## Table of Contents

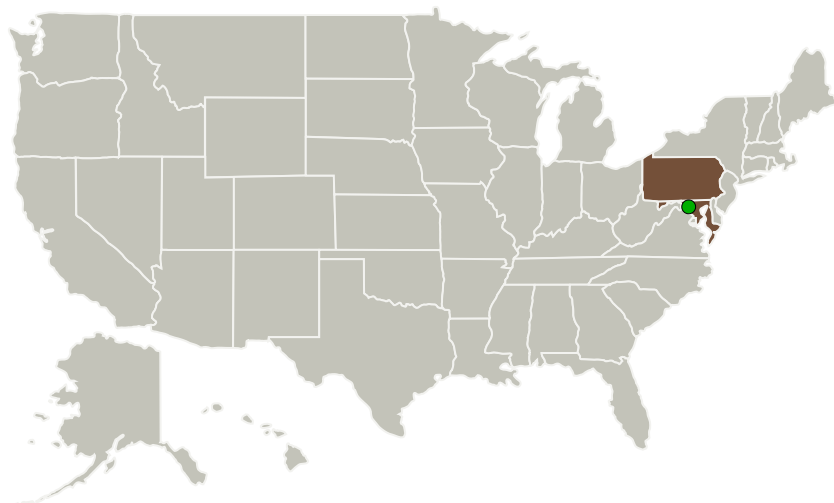
Project Introduction	1
Primary U.S. Work Locations and Key Partners	2
Project Transitions	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3

## Low Cost Variable Conductance Heat Pipe for Balloon Payload, Phase I

Completed Technology Project (2011 - 2011)



## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Advanced Cooling Technologies, Inc.	Lead Organization	Industry	Lancaster, Pennsylvania
● Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

## Primary U.S. Work Locations

Maryland	Pennsylvania
----------	--------------

## Project Transitions

**February 2011:** Project Start**August 2011:** Closed out**Closeout Documentation:**

- Final Summary Chart(<https://techport.nasa.gov/file/138265>)

## Organizational Responsibility

**Responsible Mission Directorate:**

Space Technology Mission Directorate (STMD)

**Lead Organization:**

Advanced Cooling Technologies, Inc.

**Responsible Program:**

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

**Program Director:**

Jason L Kessler

**Program Manager:**

Carlos Torrez

**Principal Investigator:**

Calin Tarau

**Co-Investigator:**

Calin Tarau

# Low Cost Variable Conductance Heat Pipe for Balloon Payload, Phase I

Completed Technology Project (2011 - 2011)



## Technology Maturity (TRL)

Start: 3  
Current: 6  
Estimated End: 6



## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.2 Thermal Control Components and Systems
    - └ TX14.2.2 Heat Transport

## Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System